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AUTHOR Friedland, William H.
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ABSTRACT

Making a case for initiation of a systematic methodology that would predict and evaluate the potential social ramifications of scientific research, this monograph presents: (1) a review of the general lack of social concern among scientific researchers and rationale for utilization of scientific agricultural research as initiator of social prediction policies and techniques (because agricultural research is systematic, incremental, applied, and funded via public resources); (2) a section on developing the art of social prediction which includes a state of the art review, a dual approach to social prediction (development of predictive and evaluative methodology), the potential advantages of social prediction (better understanding of the possible outcomes of a piece of research facilitates the process by which public policy is formed; practical concerns can be better dealt with as methodologies of prediction and evaluation develop; and analyses of the results of projected research can facilitate long range planning and benefit specific groups); (3) a section on the implementation of predictive and evaluative approaches which includes the functions of prediction (emphasis on the role of a "predictive advisor"), the functions of evaluation, and the past experience of environmental-impact statements; and (4) appendices which include an exemplary administrative structure and social-impact statement. (JC)

SOCIAL SLEEPWALKERS

Scientific and Technological Research in California Agriculture

William H. Friedland

Board of Community Studies
Board of Sociology
Stevenson College
University of California, Santa Cruz

Department of Applied Behavioral Sciences
College of Agricultural and Environmental Sciences
University of California, Davis

Research Monograph 13

Preface

This study is the first segment of a three-part research project. The companion pieces will be case studies of the tomato harvester and of an anticipated lettuce harvester. The tomato harvester represents an innovation of the recent past that has produced, and continues to produce, a variety of significant changes. The mechanical lettuce harvester will be studied to develop a predictive statement on the social effects of this proposed technological innovation.

The three studies are designed to illustrate an approach to facilitating the process by which natural and social scientists can combine skills to produce a productive effort that can benefit society. This study frankly acknowledges the difficulty in obtaining such a combination of skills and approaches. It represents, nevertheless, an attempt to initiate a discussion to facilitate the development of a new direction in scientific research: prediction and evaluation of the social effects of such research.

Research for this report was supported by the Agricultural Experiment Station of the University of California, Davis. Brad Austin, Vicki Bolam, Bill Shelton, and Bob Thomas, students at Santa Cruz, helped enormously in the necessary research. I am grateful to Valerie Anderson, Robert Loomis, Michael O'Brien, Michael Zahara and Martin Zone of the University of California, Davis, and Bert Hoyle of the West Side Field Station for the cooperation shown my students in July 1973. Suggestions and comments by Alex McCalla, Donald R. Nielsen, and Orville Thompson of UC Davis have also been helpful. The manuscript has benefited from critical reading by Dorothy Nelkin, Dennis McEnnath, and William Robinson. Amy Barton, project coordinator, has provided research and editorial support throughout.

SOCIAL SLEEPWALKERS: SCIENTIFIC AND TECHNOLOGICAL RESEARCH IN CALIFORNIA AGRICULTURE

"The progress of Science is generally regarded as a kind of clean, rational advance along a straight ascending line; in fact, it has followed a zig-zag course, at times almost more bewildering than the evolution of political thought. The history of cosmic theories, in particular, may without exaggeration be called a history of collective obsessions and controlled schizophrenias; and the manner in which some of the most important individual discoveries were arrived at reminds one more of a sleepwalker's performance than an electronic brain's." (Koestler 1959, 15).

In his study of the emergence of modern cosmological theory, Arthur Koestler used the metaphor of the sleepwalker to describe the lurchings and staggerings of Copernicus, Kepler, Galileo, and Newton as they groped toward the explanation that put the sun rather than the earth at the center of our system. This obvious fact, that scientific discovery is more a series of accidents than logical and theoretical development, seems to be continually forgotten in the scientific* enterprise. Even the most impressive scientific discoveries are more the result of "sleepwalking" than of a conscious process of rational deliberation.

The work of scientists can be called "sleepwalking" in a second sense as well: most scientific discoveries are made with little or no recognition that they may have staggering effects on society. The second form of sleepwalking might be called "social sleepwalking." It is now common to consider the tremendous social changes that have been produced by scientific and technological innovation after the fact.** However, the state of the scientific enterprise remains one in which the social potential of research and development receives little thought before a research project is undertaken. Thus, not only did Henry Ford and other pioneers in the development of the automobile fail to consider the effects their work might have on the structure of cities and the international economies of the petroleum industry, but most of us would regard it as perfectly natural for such a consideration to be ignored.

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* No distinction is made here between natural and social science; both approaches, developing a rational, analytic system for examining phenomena and predicting outcomes, are regarded as sharing a common base despite the obvious differences in approach and methodology.

** The literature on post-facto analyses of technological innovation is voluminous. See, for example, Technology and Culture, Weiss (1971), Spicer (1952) for a few examples. Studies in agricultural innovations have also been made, though less voluminous; see, for example, Bertrand (1951) and Rogers (1960).

In a somewhat similar fashion, the scientific developers of the atom and hydrogen bombs were, at best, inadequately aware of the tremendous social impact of their actions. It was only with the final development of the bomb that the moral consequences of its destructive power, rather than the impact of the technology, became an issue of magnitude to the developers.

Even today, when scientific research continues to represent a major social investment, scientists and technologists go about their work socially unconcerned, largely indifferent to the social effects of their discoveries. Few or no checks exist to weigh the consequences of their success on society. Despite some stirrings toward such evaluation, knowlege of social consequences in scientific enterprise remains in a Neolithic state.

Given this context, it would hardly be fair to expect that a highly developed state of consciousness should exist among agricultural scientists and researchers: there has been no need for them to be any more concerned with the social consequences of their research than other scientists. And, despite a few indications that some social concerns have developed among some agricultural scientists and technologists in California, prevailing indications are that most of them are typical of the breed from which they spring.

To a considerable degree, lack of interest in social consequences is a reflection of the utility of the division of labor. As labor in society has become more divided (Durkheim, 1947), it has produced enormous effectiveness in scientific productivity as well as other fields. A concomitant effect has been to compartmentalize scientific producers so that they ignore the elements of a project immediately outside their disciplinary purview. Compartmentalization not only separates scientists from other scientists, it divorces them from considering anything as remote as "social consequences." In recent decades, systems analysis and interdisciplinary studies represent approaches developed to overcome some of the handicaps consequent on specialization. Often, however, these attempts have simply introduced new forms of specialization rather than a systematically integrative approach.

Most people believe that their work lives are already complicated enough without worrying about how their work will affect others. Thus, while the division of labor has produced significant effects in terms of scientific productivity, society reels and staggers from the social impact of the scientific successes of previous years and decades. Only when social problems reach a certain magnitude do they begin to obtrude on public consciousness. And, then, the attempt to cope often follows the practices of the past: scientific analysis of the problem, a strategy to deal with it, and almost complete ignorance that any "solution" breeds future considerations with which society will have to grapple. Recently this has been embodied in the approach of the "technological fixes," in which a technological input is believed to have the capability of producing solutions to complex social problems.*

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* For a discussion of "technological fixes" see Nelkin, 1973.

While this issue can be discussed normatively or philosophically, the intent is not to treat it this way here. Rather, the obvious point must be made and reemphasized: since the work of some people will affect others it makes sense that when an enterprise is undertaken that might affect the lives of others, some attempt should be made to determine how human lives, society, and the world will be affected.

This report constitutes an attempt to get such a process under way. It should be emphasized at the outset that the art of social prediction is in a primitive state. It must also be stressed that this primitiveness exists in the social sciences as well as the physical sciences. As Merton (1957, 93-101) has pointed out, post-facto analysis has been a pervasive element in the social-science approach. In this respect, then, there is no basis for social scientists to take a superior stance vis-a-vis physical scientists; neither have developed modes of analysis useful for predictive purposes.

If the state of the art of social prediction is weak, the argument is strong for initiating a more coherent art, a stronger predictive capability. Science has been too long involved in social sleepwalking; yet the consequences become ever more significant as population increases and as world integration develops. The need to make a start in the development of a methodology of social prediction becomes all the more vital as science and technology increasingly dominate our lives.

That such a beginning is overdue is clear in the interest of some scientific circles in technology assessment (Brooks and Bowers, 1970). Some early attempts at such assessment are now getting under way (Bowers and Frey, 1972). The creation of a Federal Office of Technology Assessment in response to demands for better knowledge of the effects of technology also indicates the growing interest in this subject.* Thus, study of the social consequences of scientific research appears to be an idea whose time has come.

In approaching the complex which has developed in scientific agricultural research as a potential locus for initiating social prediction, the orientation is to call again on an important complex to make a basic contribution to the generation of knowledge. The agricultural sciences appear suitable for such a start because of four distinctive features:

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* The creation of OTA has not been universally acclaimed. See, for example, the critical comments by Peter Drucker, New York Times, March 15, 1973. Drucker agreed that the OTA would create a "full employment law for second rate novelists" and contended that it was neither possible nor desirable to assess major new technologies. He subsequently repeated this criticism while endorsing the utility of technological monitoring, (N. Y. Times, April 8, 1973, Section III). Drucker's views stimulated a host of comments (Cf., N. Y. Times, April 22, 1973, and May 13, 1973, Section III).

Research in agriculture is systematic, generating knowledge over a range of problems from the most basic and theoretical to the most applied and practical.

Agricultural research is incremental, involving a series of differentiated studies that accumulate over time and have social effects in relatively constrained and limited situations rather than being as globally influential as many other forms of research.

Because of the fundamentally applied character of agricultural research in dealing with more effective production of food and fiber, agricultural research has a tendency to produce social effects more immediately than other forms of research.

Agricultural research is heavily funded through public resources, and the outcomes produced through such research should be amenable to considerations of public policy. Thus, it is suggested that public debate on the outcomes of publicly funded research would produce more rational decisions as to the direction of research.* The delineation of research problems would continue to rest with scientists; the decision as to which research problems to study would increasingly become a matter of public discussion.

Developing the Art of Social Prediction

The State of the Art

Post-facto analysis of science and technology, as well as of technical/administrative procedures, has been the prevailing mode of approach to an understanding of social effects (Technology and Culture; Selznick, 1953;

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* One issue which should be dealt with at this point is that of maintaining an ostensibly free and open science unhindered by political influences. When scientists oppose the "pressures" created by Congress for the direction of research or argue for "free" and open research, often with public tax funds supporting such work, the argument fundamentally boils down to groups of disciplinary professionals making the decisions as to the directions of research. See, for example, "Physicist Scores Research Trend," New York Times, October 7, 1973, p. 28. No attempt is made here to argue that scientists should be constrained in the direction of their research. If public funds are involved, however, the public should have the right to know the purposes of such expenditures. Further, if a scientist could predict that the outcome of a discovery would be socially catastrophic, should he be permitted--or permit himself--to indulge intellectual curiosity?

Banfield, 1951). In addition to technology assessment, two additional approaches to a better assessment of processes of change are worth noting. First, PPBS, now utilized by many government agencies, and similar systems found elsewhere represent an attempt to measure the degree to which objectives are attained and at what costs. In this sense, PPBS is not a predictive system as much as it is one intended to produce a more vigorous and continuing evaluative process. Second, within social science, evaluative research has emerged as an attempt to assess more accurately the effects of programs intended to produce planned social change.

Evaluative research crystallized during the late 1960's as an element in the War on Poverty (Moynihan, 1960; Sundquist, 1969) although it had earlier antecedents (Suchman, 1967) and has had considerable follow-up work (Caro, 1971; Rossi and Williams, 1972; Weiss, 1972). The need for more rigorous evaluative research flowed from the proliferation of innumerable evaluative reports commissioned as a result of programmatic requirements by the Office of Economic Opportunity during the final stages of the late War on Poverty. Many of these reports were little better than elaborate puff-sheets commissioned by poverty agencies to justify their existence and the need for annual refunding. Most of this work was not only self-serving and unnecessary but there was little cumulative development of analytic methods to provide guides for a more effective evaluative methodology.

If little methodological development has occurred, the evaluative efforts of the War on Poverty have at least alerted many social scientists and policy-makers to the need for a continuing assessment of programs of planned social change. Although the art remains weak in methodology, the basis has been created for continuing evaluation as well as post-facto evaluation.

A summary assessment of the state of the art therefore indicates:

First, there exists almost no predictive or continuing assessment of the social effects of scientific and/or technological developments. Further, except for a few primitive developments, little thought or consideration is being given to this problem except in a few remote segments of the scientific research establishment.

Second, some primitive beginnings have been made in evaluating programs of planned social change. This approach emphasizes the concept of evaluation during the implementation of such programs, although they also contain an implicit intention of assessing such programs predictively. Evaluative research has been given some consideration in a few segments of the social-science research establishment but remains a relatively esoteric phenomenon.*

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* Few catalogs of colleges and universities examined in recent years offer, for example, courses in evaluative methodology.

A Dual Approach to Social Prediction

This assessment of the state of the art suggests the need for two distinctive approaches to social prediction, whether results investigated are the consequences of scientific and technological research or of programs of planned social change.

First, there is a need for developing a predictive methodology--sets of methods that can be utilized, whether by scientists or social scientists, to grapple with a better understanding of the intended outcomes of a specific piece of research. In many respects, predictive methodology is implicit in all programs of planned social change; thus the task of predictive methodology as far as social science is concerned is to make predictions more explicit, conscious, and deliberate. In the case of the natural sciences and technologies, the intended outcomes, as far as society is concerned, of a given piece of research are given consideration by researchers only in the rarest of circumstances.

Second, the need is also clear for a second methodology, evaluative methodology. Evaluative methodology is seen as a process of assessing a set of outcomes of the introduction of science (whether natural or social) and/or technology during and after the development of an innovation. Thus, the distinction between predictive methodology and evaluative methodology is that the former seeks to develop methods which will facilitate better predictions concerning outcomes, and the latter develops methods that assess outcomes as they occur.

Conceptually and analytically, there is a distinctive difference between the two approaches since a predictive methodology must develop from a more uncertain basis. Evaluative methodology, in contrast, begins with some implicit sets of expectations concerning outcomes; this provides some guidelines within which evaluative research can occur. While evaluative methodology must be concerned with outcomes that are latent as well as those which are intended, the capability of assessing a process while it is under way makes the development of such an approach simpler than developing a predictive capability.

Potential Advantages

Several distinct advantages are seen in such predictive and evaluative capabilities.

First, a better understanding of the possible outcomes of a piece of research can facilitate the process by which public policy is formed. At present, no explicit criteria exist as to why one piece of research should be done as against another. Various groups that participate in the decision-making process in political life may hold such criteria explicitly to themselves, but there is rarely a public discussion about such criteria let alone about whether a distinctive thrust in research will produce outcomes held to be socially valuable. Developing a more rigorous capability for predicting and evaluating outcomes will facilitate

the process of public discussion on the utilities of research, e.g., what research is regarded as socially useful.*

Second, many practical concerns can be dealt with better as methodologies of prediction and evaluation develop and gain sophistication. Considering these concerns solely from the viewpoint of the most immediate participants in agricultural production, various practical developments can aid the different parties in agriculture by handling the process of change with greater facility.

Growers, for example, mainly experience change in agriculture as a process of grappling with immediate or impending problems. Whether the problem is an immediate one such as a new strain of disease, or impending in the form of a long-range constriction of the labor supply, the tendency is largely to deal with such problems on an ad hoc basis: most long-range problems tend to be overwhelmed by the immediate and impending. Thus, development of predictive and evaluative methodologies focuses attention on long-range developments and can provide contexts for better planning and adaptation on the part of growers.

From the viewpoint of farm workers, change is not the result of a conscious and deliberate process but simply one in which, for example, the number of workers needed for a particular crop is smaller this year than last. Workers are left mainly to themselves to deal with such problems although agencies exist intended to connect them with new sources of employment. The inability to assess future labor requirements more accurately precludes planning for a transition to new skills. Manpower training programs have tended to function more simply to develop occupational skills than with conscious understanding of trends in the market. Retraining and better communication concerning developed occupational skills could be facilitated by a more accurate understanding of what is going to happen in agriculture in the next half-decade.

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* The intent here is to establish a situation similar to that expressed as existing in the California Farm Bureau where "no member questions his right to have a say in the development of policies and the operation of the Farm Bureau. How much better off society would be if this same attitude extended to other institutions." (Allan Grant, "President's Message," California Farm Bureau Monthly, September 1973.) Mr. Grant paradoxically goes on to attack a group of faculty in the University of California which "is pressing for adoption of a proposal which would subject all research undertaken to a social value test." In fact it is not now possible to implement a social-value test for research outcomes since there exists no predictive capability and only primitive evaluative capability. The point is that the development of methodologies concerning social outcomes is crucial before citizens can have a better say about the development of policies in the operation of our society.

Better analyses of the results of projected research in the agricultural sciences can also facilitate long-range planning in the broader society as well as benefit other specific groups affected more directly by changes in agricultural production methods.

Implementing Predictive and Evaluative Approaches

Implementing an approach to prediction and evaluation of results of scientific and technological research will clearly create a number of new problems in an agency such as the Agricultural Experiment Station. Since new procedures would inevitably face scientific investigators with demands for which they are relatively unprepared, some coolness to this approach can be expected. Moreover, the process by which investigators must anticipate outcomes before undertaking research will surely introduce a great many personal uncertainties. Even so, it should be evident that the development of more effective predictive and evaluative capabilities will have strongly beneficial effects for the operation of institutions such as the Experiment Station.

The first need is a method that creates a basis that makes prediction and evaluation possible. In proposing a specific procedure, it is necessary to emphasize that what is envisioned must begin in the most tentative of ways and that no great expectations can be had that, in the initial phases, the proposed procedure will operate with smoothness or have great accuracy. Not much can be expected in the beginning; but unless a beginning is made, less can be expected in the future. An estimated time frame of approximately ten years must be allowed for development of predictive and evaluative capabilities. What is needed is a structural exigency, established within the Experiment Station, so that meaningful and practical attention will be paid to developing predictive and evaluative capability. As a beginning, it would be advisable to require a Social-Impact Statement for each proposal submitted to the Experiment Station for research support. The basis for such a Social-Impact Statement already exists within the proposal request format used by the Agricultural Experiment Station in the allocation of funds. A number of questions already deal not only with the intent of the research but with the outcome of the research as well. The Social-Impact Statement should consist of a number of questions that might appear as follows:

1) Who may be affected either directly or indirectly by this research?

2) How will these effects be manifested on different groups in society or in society generally?

3) When might these effects be expected? What are the short-term effects? What are the long-term effects?

4) What areas of expertise other than your own might be consulted for evaluation of this research?

It is probably valid to assume that, from an investigator's viewpoint, a Social-Impact Statement will be only an additional imposition on an already overlong number of requests for information. However, although most investigators fill out the requisite forms paying due attention to the delineation of the problem proposed for research, the methodology to be used in investigation of the problem, and the budget, most pay little attention to such subjects as would fall under "justification." It is precisely the issue of justification that the Social-Impact Statement would bring sharply into focus.

It is not enough, however, to require a Social-Impact Statement. For such statements to provide an input into research development, formal units will have to be created to examine and analyze the Social-Impact Statements over time. A structure that could ensure the effectiveness of the Social-Impact Statement would be a "Predictive and Evaluative Methodology Unit." Some specific suggestions for developing this unit structurally are included in Appendix 1. It is important here to note the functional activities that will be necessary for such a unit to operate vis-a-vis the Social-Impact Statements.

The Functions of Prediction

The major emphasis probably required in the initial phases of developing predictive capacity will likely center on encouraging investigators to overcome a natural reluctance to move into uncharted areas and to give them the best technical assistance available, given the primitive state of the art, in developing their Social-Impact Statement. Beyond inserting a new set of questions that implement the social-impact statement requirement, therefore, it would be advantageous to create a new functional role of "predictive advisor."

Such a role should be concerned with:

1) Meeting with investigators as a group and on an individual basis to explain the character of the Social-Impact Statement and to explicate the state of the art with respect to predictive techniques as well as to elucidate the specific techniques presently available.

2) Working with individual investigators to help them prepare Social-Impact Statements for specific projects.

3) Serving as an immediate review mechanism for all Social-Impact Statements and to provide suggestions to investigators who have not availed themselves of such services for improving their Social-Impact Statements.

4) Provide information to internal-review committees on the qualities of Social-Impact Statements.

Over time, as experience develops, the work necessary in providing predictive capability will invariably expand and become more sophisticated. An important formal responsibility of incumbents in such a position would concern contributions to the evolution of this field. Such a requirement should be formally incorporated into the job description and be made part of the review process of a person's work.

The Functions of Evaluation

Although predictive analysis can begin as soon as there is a requirement that Social-Impact Statements become part of a research proposal, evaluative analysis will become feasible only as research is completed and the findings dispersed and implemented.

The functions of evaluative analysis are seen as:

1) Initially and declining over time, evaluation studies should be conducted of past research to elucidate general approaches. A small number of projects, ranging from the most immediate and practical research in terms of social consequences to the most theoretical research, should be defined for potential investigation. Initially, the crucial criterion for selection might be to choose projects defined as successfully completed.

2) As Social-Impact Statements accumulate, the evaluative unit can select a range of research projects from which social consequences could be studied. This would mean that, while research projects are being completed, evaluators would examine on a continuing basis how research findings are implemented. Consequences should be studied while the effects of the research are actually in process. In selecting a range, attention should be given not only to having a selection of projects ranging from theoretical to practical, but also to Social-Impact Statements prepared solely by an investigator and those prepared with the assistance of personnel from the predictive unit.

3) Evaluators should provide appropriate feedback as impacts are determined so that evaluators can clearly define the differences between the original Social-Impact Statement and the outcome as empirically determined. Such feedback should go directly to the investigators who originated the Social-Impact Statements.

4) Evaluators should generate methodological suggestions to predictors for improving predictive capability in preparation of Social-Impact Statements.

5) Evaluators should be held responsible for contributing to the formulation of an evaluative methodology serving broader interests by developing vigorous evaluative capability.

The Experience of Environmental-Impact Statements

While no systematic analyses have yet appeared on the legal requirements for environmental-impact statements and the consequences these have had on the planning process, some tentative impressions are possible from having watched the requirement implemented in a number of local situations.

First, it is clear that the requirement for environmental-impact statements has not stopped the process of planning and land development. After an initial period of shock, the process has been reestablished.

Second, there have burgeoned a number of organizations and procedures necessary to fulfill the technical requirements of the law. The resulting statements range in quality from thorough and solid analyses of anticipated impacts on environments to the shoddiest impressionistic statements.

Third, an important element in the environmental-impact statement procedure is that the fundamental assumptions of a developer become subject to public scrutiny.

Finally, unless an involved citizenry has the technical capability to study environmental-impact statements and a commitment to deal with them, such statements will have little meaning for the planning process, which will thus return to the exclusive preserve of interested parties and technicians, e.g., developers, planners, and politicians.

The experience thus far obtained with environmental-impact statements as applied to a requirement for the preparation of social-impact statements would indicate that the initial shock period will rapidly be overcome as investigators learn to fulfill a new set of expectations and as technical advice is made available to them through personnel capable of fulfilling the predictive functions. Further, it would appear to be useful to seek some means by which a more public review of research proposals can be obtained. "Public" in this context does not necessarily mean a public hearing conducted before public planning bodies. Rather, the intent is to get beyond the restricted in-house review procedures currently operating within the University and to open the review process to a University public. Such a development would be new and would inevitably create a great deal of unease among investigators. The need for a broader review process, involving the university "public" at a minimum, would appear to be necessary in a period in which research funds are continually being restricted and political leaders are calling into question the utility of massive expenditures for such research. Simply put, if the university wishes to have continued public support for research it must develop more public means by which research proposals are reviewed. Finally, the experience with environmental statements indicates that the best situation will occur precisely when a university public can interact with Social-Impact Statements. The creation of a critical and informed audience serves as a device for developing a base to support research, not simply to restrict it.

Appendix 1: Administrative Structures for Implementing Predictive and Evaluative Functions

The functions discussed earlier can be administered in a variety of ways. This appendix suggests means of implementation to fulfill the functions elaborated. Other means can be devised and may be suggested by readers. These specific suggestions should not detract from discussion of the substantive proposals embodied in the report itself. This appendix deals initially with a proposed organization structure and then examines some personnel qualifications seen as necessary to fulfill the functions described. It is conceived as fitting within the organizational structure of the University of California and its Agricultural Experiment Station, but the basic ideas can be applied in other contexts.

Organizational Structure

It would appear useful to create a single administrative entity within the Agricultural Experiment Station that would have a certain degree of autonomy. Since the proposal deals only with research funded through the Station, the proposed entity should be part of that Station. At the same time, the Agricultural Experiment Station has a lengthy history, with many comfortable social relationships developed within it over the years. It would be advantageous to obtain some degree of autonomy for the proposed organization so that its work can be reviewed by an audience not enmeshed in the continual day-to-day work of the Experiment Station and the College of Agricultural and Environmental Sciences of the University of California.

This goal can be reached by creating an advisory committee composed of faculty to review the work of the entity and advise the Vice-President, Agricultural Sciences. The work of such an advisory committee should be public in the sense that its reports should be matters of public record within the University. The committee should be composed of individuals who are part of the agricultural organization of the University as well as those with professional competence but without such a relationship.

The specific entity suggested, a Predictive and Evaluative Methods Unit (PEMU), should distinguish organizationally between the functional activities of prediction and evaluation. This can be accomplished by the formation of distinctive subunits, one dedicated to providing predictive capability and the other to evaluation. Because of the interrelationship between the two activities, it would appear advantageous to maintain some degree of coordination while differentiating the work of the subunits. This can be accomplished organizationally and geographically. Organizationally it can be resolved by creating a single entity, the Predictive and Evaluative Methods Unit, with a directing head, and two subunits. Organizational separation can be enhanced by geographical dispersion: thus, it might be advantageous to house predictive personnel on campuses where the major research efforts are housed, e.g., Davis and Riverside, while locating the evaluative subunit at another location.

The organization chart for the suggested Predictive and Evaluative Methods Unit, is shown in Chart 1, page 14.

Personnel Characteristics

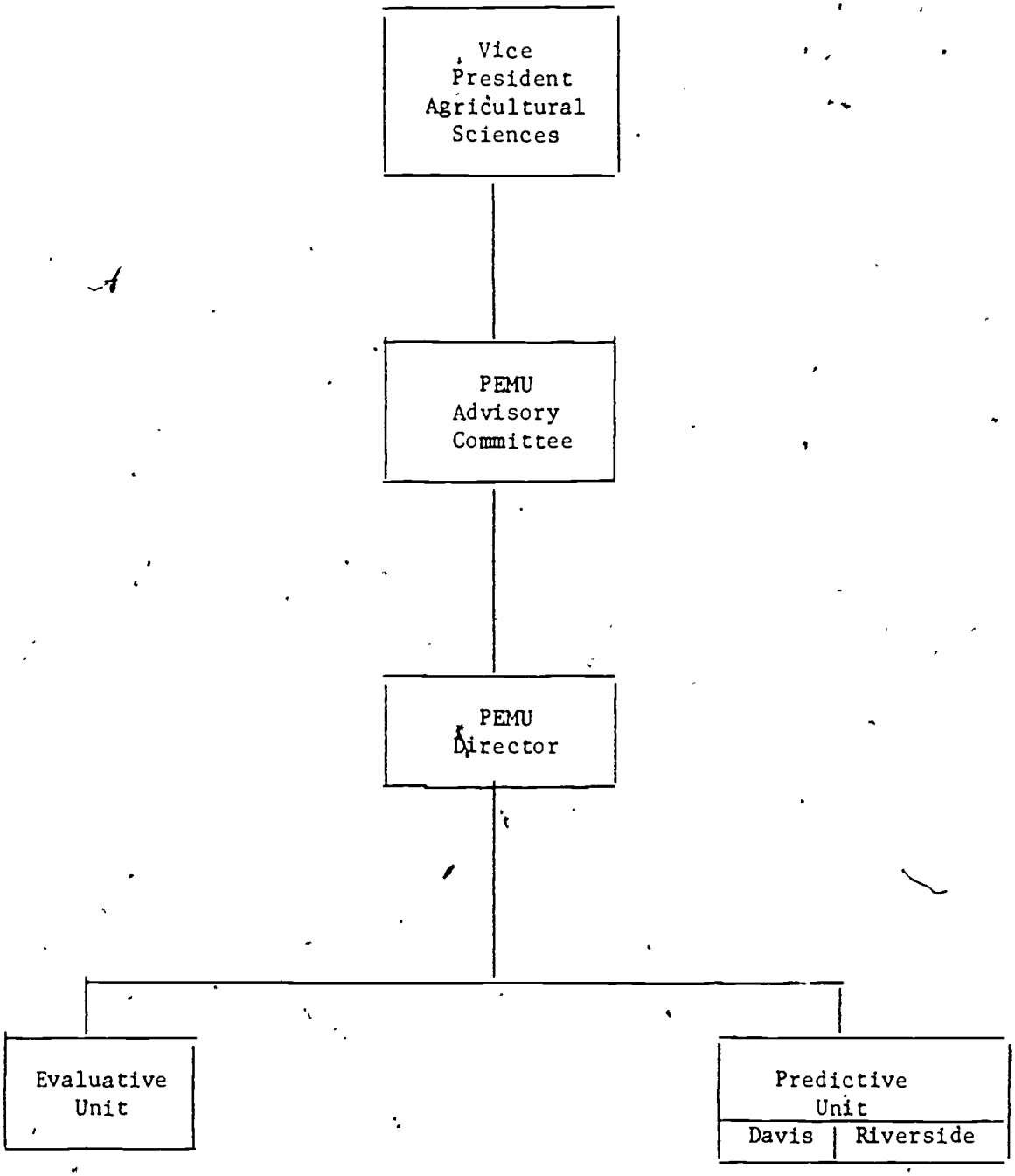
The pool of scientists--natural and social--with competence to sustain predictive and evaluative analyses is presently small; the specific areas to be developed are primitive. Accordingly, it is possible to suggest the characteristics or requisite personnel only tentatively, and to indicate some measures necessary to review their work.

The types of scholars necessary to fulfill predictive or evaluative responsibilities will be rather similar; at the moment, it is not clear that the work necessary for predictive analysis will be significantly different, in terms of personnel requirements, from that of evaluation. The personnel types suggested should be not only scholars of proven research competence in existing fields or disciplines but ones who experience an urge to explore uncertain areas. It would seem certain that interdisciplinary strength, e.g., persons not focused on a single disciplinary approach, will be necessary. It would also appear important that such personnel be sophisticated in qualitative as well as quantitative methods. Qualitative analysis is essential to elucidation of latent elements that are part of any change process. Sophisticated quantitative capability will be necessary to support the need for the development of criteria for measurement. There is a strong likelihood that personnel with distinctive competence in systems analysis and/or operations research might be necessary.

One difference, at least initially, between personnel fulfilling predictive functions and those involved in evaluation centers would be that predictive personnel need to be able to work with a wide range of investigators in facilitating the preparation of social-impact statements. Accordingly, this would indicate a need for strong interpersonal skills and abilities that would be less requisite for evaluative personnel.

It would undoubtedly be advantageous for predictive and evaluative personnel to have instructional responsibilities. Instructional requirements could provide a useful opportunity to confront a critical audience on a continuing basis. Such an audience may well have values discrepant from those held by investigators, and instruction could provide a valuable intellectual exercise ground. Potential clashes over values will create a useful tension for the staff of the Predictive and Evaluative Methods Unit (PEMU) in that it should make them sensitive to the conflicts of interests that can and do exist over the social consequences of research. Departmental affiliation would be useful for those carrying on instructional functions. Teaching and departmental alliances will throw PEMU staff into contact with peers and will institutionalize review procedures necessary to critical judgement of their work. Staff should be attached to interdisciplinary units rather than to single discipline units, so they can develop awareness of the effects of research in a variety of fields. Thus, not only will the potential effects of research in other areas be accounted for, but developments which may be of use to other disciplines can be shared.

Chart 1: Organizational Structure for Predictive and Evaluative Methods Unit (PEMU)



Appendix 2: Social-Impact Statement for this Study

(This appendix has been prepared as an example of how a social-impact statement might respond to proposed questions. This statement was prepared after the fact rather than before; in other respects, however, the statement responds as accurately as feasible to the questions asked.)

1) Who may be affected directly or indirectly by this research?

This project is expected to affect a number of campus research constituencies directly and indirectly. Researchers seeking funding through the Agricultural Experiment Station will be affected immediately, should such a proposal be implemented, by being required to respond to a number of questions with which they have had little experience and about which they claim little or no expertise. More indirectly, they will experience distinct concerns about the issue of accountability, e.g., the long-range effects of their work. Over a period, as predictive and evaluative techniques improve and become part of a transmittable body of knowledge, researchers will have to familiarize themselves with the basic parameters of such knowledge, which may have some broadening influences on their work.

University administrators will be affected less directly than researchers but will experience problems in delineating criteria for determining how research allocations should be made. The issue of accountability will become more pressing for administrators than for researchers, especially if research support from public resources continues to decline or remains steady.

Elements external to the university will be affected indirectly and in the long run. The effect should clarify the nature of research and the social groups affected most directly.

2) How will these effects be manifested on different groups in society and in society generally?

The immediate groups to be affected are researchers on University campuses and administrators. A second category will be social groups that benefit from the conduct of university research. Research currently tends to benefit some groups more than others; the requirement that researchers prepare social-impact statements will make groups more aware of the resource allocation process. A third category that may be affected is groups which potentially can benefit from university research but are not currently benefiting; whether they will seek to delineate potential benefits is not clear.

The general effects in society should be to make more clear the political issues involved in resource allocation for research purposes. In this respect, it will simply add some new elements to the political process without, in all likelihood, changing the character of that process.

3) When might these effects be expected? What are the short-term and long-term effects?

Two concrete short-term effects might be: 1) the creation of four high-level jobs; and 2) the need for researchers to come to terms with public demands—in particular, adapting to the notion of public accountability for their research activities.

Long-term effects are more difficult to predict. It is reasonable to anticipate some significant interaction between social and natural sciences. The proposal could stimulate new work in systems analysis and interdisciplinary research. The development of predictive and evaluative capability would invariably affect the character of a political discussion about programs involving social change.

Long-range effects can be expected to be felt only after about five years of experience or more. Time will be necessary to develop a base of predictive statements and gain experience with this methodology; an even longer period will be necessary to determine the utility of evaluative research.

It can also be expected that an important distinction will develop between theoretical and applied research, with impacts being felt, predictively and evaluatively, much earlier with the latter than the former.

Groups with different interests in agriculture should become more articulate. This may create an increase in attempts to structure research output. There may therefore develop more research marketing orders as commodity groups push for sustained research. Through marketing orders and commodity pressure groups, research funds may become increasingly available for specific mission-oriented research. It is possible that there will be a higher degree of interaction between the legislature and organized commodity groups.

4) Are there any areas of expertise other than your own that might be consulted for evaluation of this research?

A great many. Helpful for this particular project would probably be consultation with economists, physical scientists, other social scientists, systems analysts, community developers, and assorted special-interest groups.

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